8 January 1975

MEMORANDUM FOR THE RECORD

SUBJECT : Lear-Siegler v. United States
Court of Claims No. 192-74

REFERENCE: Memo dtd 5 Nov 74 to DD/ORD/DDS&T fm AGC/OL, same subject

1. Based on the replies to the referent, I have told Mr. Plotkin, Justice patent attorney, that I had been unable to learn whether or not a description of the alleged invention involved in the subject infringement suit had ever appeared in print. I did suggest, however, that he might want to query AEC, in as much as there was a possibility that Teflon might have originated during the course of work done under the MANHATTAN project. Plotkin allowed that this possibility had not occurred to him. He was profuse in his thanks for the suggestion. As regards to his contacting Dupont, he said they had already been down that route without success. He also discounted the possibility that the record research talents of the A. D. Little Company could be of any help.

2. In conclusion, Plotkin again expressed his thanks and wished us well in our "battles on the Hill and elsewhere."

STATINTL

Associate General Counsel

cc: OGC

OGC Has Reviewed

5 NOV 1974

MEMORANDUM FOR: Deputy Director of Research and Development, DD/S&T
Executive Officer, Office of Technical Service, D&E, DD/S&T
Chief, Procurement Management Staff, DD/S&T

SUBJECT : Lear Siegler, Inc. v. United States
Court of Claims No. 192-74

1. Justice has advised that the United States is being sued for infringement because a Government contractor used a patented item without a license. They have requested our assistance in determining whether or not the alleged invention may have been described in a U.S. or foreign publication prior to June 16, 1959. To this end, they have provided copies of U.S. Patent 2,885,248 and U.S. Patent Re 24,765. I am advised that these patents concern an oil-free Teflon bearing that is used in the landing gear of jet aircraft.

2. Could each of you have the enclosed patents reviewed on the chance that we might have knowledge of a prior publication? STATINTL

[redacted]
Associate General Counsel

Att

2,885,248

MOLDED BEARING HAVING LOW FRICTION MATING SURFACES

Charles S. White, Birmingham, Mich.

Application June 16, 1955, Serial No. 516,003

6 Claims. (Cl. 308—239)

This invention relates to bearings, and particularly to a built-up type of bearing made from resinous, sintered and like materials.

Various attempts have been made heretofore to employ plastic resinous material for bearings which for certain applications have proved satisfactory. For heavy or concentrated loads, such bearings have proved inadequate, primarily because the material which provided strength against flow had high friction characteristics.

In one form of the present invention, a thermosetting type of resin material is employed which is shaped to the form of a mating bearing element when in postsettable stage so that after it is shaped to mate with a bearing surface it may be hardened by the application of heat. The material is built up to provide strength against flow and distortion under load and the bearing surface is preferably formed of an embedded resinous material which has low friction characteristics so that little resistance to initial breakaway is offered.

One method of forming the plastic insert for a ball and socket assembly, by way of example, would be to employ circular fabric disks to form a solid background. Such disks are made of light canvas impregnated with phenoformaldehyde resin or a similar type of thermosetting resinous material. A final layer of Teflon cloth is placed on the plurality of layers which are then cold-shaped into a semispherical form in a die set or similar device. This assembly is then placed in the cavities of a die set of a type to which pressure and heat may be applied. The time and heat are accurately regulated so as not to completely cure the resin material but have it retained in a postsettable stage. The assembly thus made has the Teflon cloth physically bonded thereon by the passage of the resinous material through the interstices of the cloth. The surface of resinous material formed over the threads of the Teflon cloth is removed by some simple process, such as vapor blasting and the like. A fluid under pressure containing a fine abrasive is directed over the surface to remove the resinous material and expose the threads of the Teflon cloth material.

During the molding stage, the cavities and mating die portions are so shaped as to provide projections and recesses on opposite sides of the inserts. The recessed areas are provided on the bearing surface to retain a lubricant therein, while the mating projections on the opposite side engage recesses in the supporting member which positions and anchors the insert against a turning movement. It is to be understood that a bonding material may be placed between the surfaces of the insert and supporting member to further securely anchor the insert in place. The insert is placed between a ball and socket of a joint and pressure is applied between the ball, insert and the socket in an amount depending upon the size of the joint to cause the material of the insert to form itself accurately to the ball and the cavity of the socket. While in pressure relationship, heat is applied at a temperature sufficient to set the resinous material to have the insert hardened when in mating relationship with the bearing surface. When lubrication is desired, a lubricant is placed within the recesses of the insert and the mating surface of the ball before the pressure is applied to the assembly. In certain applications the Teflon material will provide the necessary lubricating features since it is of the low friction type and no noticeable amount of increased force will be required for initially breaking the joint.

Accordingly, the main objects of the invention are: to provide a bearing made of a material sufficient to resist deforming when loaded and having a low friction material embedded in the bearing face thereof; to provide a bearing made of a resin material having a low friction resinous material embedded in its bearing surface which reduces resistance to break-away and provides a cool operating bearing surface; to construct a bearing of sintered material having embedded in the interstices thereof a low friction material which provides low friction operating characteristics to the bearing; to form a bearing of a backing material in postsettable stage having embedded in the mating bearing surface a low friction resinous material, all of which is formed to a mating bearing surface under pressure and hardened by the application of heat, and, in general, to provide a bearing made of a formable material having embedded therein a low friction material, all of which is simple in construction and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a sectional view of a ball and socket type of bearing, embodying features of the present invention;

Fig. 2 is a broken sectional view of a ball and socket joint, similar to the joint illustrated in Fig. 1, showing another form thereof;

Fig. 3 is a sectional view of a joint, similar to that illustrated in Fig. 2, showing a further form which the joint may assume;

Fig. 4 is a view of a splined shaft and socket having a bearing sleeve therebetween to provide a perfect engagement between the splined areas thereof;

Fig. 5 is a sectional view of a plastic insert employed in the ball and socket bearing of Fig. 1;

Fig. 6 is a broken sectional view of the structure illustrated in Fig. 5, taken on the line 6—6 thereof;

Fig. 7 is a plan view of an impregnated disk a plurality of which form the body portion of the insert of the bearing illustrated in Figs. 2 and 3;

Fig. 8 is a sectional view of a plurality of the disks illustrated in Fig. 7 shown in stacked relationship;

Fig. 9 is a view of the stacked disks of Fig. 8 after being cold formed to semispherical shape;

Fig. 10 is a view of an insert molded from the assembly of Fig. 9;

Fig. 11 is a plan view of the structure illustrated in Fig. 10;

Fig. 12 is a sectional view of the structure illustrated in Fig. 10, taken on the line 12—12 thereof;

Fig. 13 is an enlarged, broken sectional view of the bearing surface of the inserts illustrated in Figs. 5 to 12 inclusive;

Fig. 14 is a perspective view of a heavy bearing embodying features of the present invention;

Fig. 15 is a sectional view of the structure illustrated in Fig. 14, taken on the line 15—15 thereof;

Fig. 16 is an enlarged, broken plan view of a surface of a bearing formed from sintered particles;

Fig. 17 is a view of a bearing similar to that illustrated in Fig. 14, when in cylindrical shape, and

Fig. 18 is a broken sectional view of the structure illustrated in Fig. 17, taken on the line 18—18 thereof.

In Fig. 1 a ball and socket joint 21 is illustrated mounted on a yoke 22 having a spindle thereon (not shown) for supporting a front wheel of a vehicle. In Fig. 2 a ball and socket joint 23 is illustrated mounted on the bottom end of the yoke 22, both of the joints being shown in position of assembly, the joint 21 being disposed at an angle to the vertical. The joint 21 comprises a truncated ball 24 having a stud 25 thereon provided with a tapered portion 26 terminating in a threaded end 27. The stud is secured by a nut 28 to one arm of the yoke 22. A dished stamping 29 mates with an apertured dished stamping 31 about the ball 24, the two stampings being assembled on a supporting arm 32 of the vehicle by suitable means, herein illustrated as by bolts 33. A sealing element 34 is sealed to the dish-shaped stamping 31 and the stud 25 of the ball 24 to prevent the entrance of dirt and grime to the cavity about the ball. A pair of oppositely disposed, truncated, hollow spherical inserts 35 is mounted about the ball in pressure engagement with the stampings 29 and 31.

The ball and socket joint 23 of Fig. 2 embodies a stud 36, similar to the stud 25, having a socket 37 thereon in place of the ball 24. A cup-shaped element 38 surrounds the socket 37 and contains a truncated solid ball 39 on a stem 41 which is mounted on a supporting arm 42 of the vehicle by a washer 43 and nut 44. A sealing element 34 seals the cup-shaped element 38 and the stud 36. Between the socket 37 and the ball 39, an insert 45 is provided, constructed in a manner hereinafter described.

In Fig. 3 a similar ball and socket joint 46 is illustrated, employing the same stud 36 and socket 37 but having a hollow ball 47 provided on a stamping 48. A dish-shaped stamping 49 mates with the stamping 48 and permits a seal to be employed between the stamping 48 and the stud 36. An insert 45 is employed between the ball portion 47 and the socket 37.

Referring to Figs. 5 to 13 inclusive, the manner of constructing the inserts 35 and 45 will now be described in detail. The main body portion of the insert may be of any material known in the art to be suitable which has a presettable stage so that it may be formed to the shape of a mating bearing surface and set thereafter. In the example shown, the insert is made up of a plurality of layers of cloth material, such as light canvas impregnated with a suitable resinous material. The layers 51 are preferably cut in circular form and stacked upon each other. The top layer 52 which is to form the bearing surface is of Teflon cloth material which will be physically bonded to the resinous material of the disks 51. It is to be understood that the mentioning of the phenoformaldehyde material impregnating the disks 51 was by way of example since it is well known to those skilled in the art that other types of thermosetting resins may be substituted therefor. It is to be further understood that the resin material may be used to form the body of the insert without the cloth material embedded therein and with the layer of Teflon or like low friction material embedded in the bearing surface.

The Teflon material 51 is a type of resin which will withstand 600° operating temperature. This is desirable to produce bearings which must withstand such temperature. A resin for the body would be employed which is moldable to a desired shape at such high temperatures but which will, upon cooling, become permanently set. The Teflon cloth, when employed in combination with such thermoplastic materials, will produce the low friction type of surface to the bearing and will withstand therewith the high operating temperatures. The Teflon material itself could not be employed successfully to construct such a bearing since above 600° F. it becomes jelly-like in form and flows under pressure when in a cold stage. The combination, however, of the Teflon cloth on the surface of a bearing constructed of either thermoplastic or thermosetting material provides the desired low friction characteristic, while the solid backing body portion prevents any deforming or flow of the material. The Teflon cloth herein referred to is by way of example, since other low friction material, such as nylon and the like, may be substituted for the Teflon on the bearing surface of the insert or bearing body.

Powdered Teflon, nylon and like substances were first employed upon the surface of the insert but, due to the cold flowing of these materials under pressure, they could not be retained in contact with a mating bearing surface. By employing such materials in sheet form, such as woven cloth, perforated sheets, or sheets having granular surface, or fibers woven into a porous material having interstices so that a physical bond could occur between such sheet material and the backing material, satisfactory retention of the low friction material is obtained. The physical bonding of the low friction material by the backing material prevents the cold flowing of the Teflon or like material and the low friction characteristics are maintained between the mating bearing surfaces. Before the final presetting stage, it is desirable to remove the film of bonding resin material from the surface of the low friction material by some suitable means, as by air blasting or the like, as hereinabove mentioned. In some types of bearings, the film of bonding resin material will wear rapidly away, exposing the low friction material which will then be in contact with the mating bearing surface. When employing the Teflon, and like materials, providing the low friction characteristics, the resulting bearing will have a low friction break-away, coupled with the antifriction properties which are desirable between the bearing surfaces.

After the several layers 51 have been assembled with the top layer 52 of Teflon, or like material, the assembly is then cold shaped to a semispherical form, as illustrated in Fig. 9. These assemblies are then placed in a multicavity mold and shaped to the form illustrated in Figs. 10, 11 and 12 under pressure and heat, the heat being applied for a sufficient time to cure the resinous material to the presettable stage. The mold for the insert 45 is so formed as to provide slots 54 on the outer face of the insert disposed at right angles to each other and inward projections 55 on the inner face in alignment with each other. As illustrated in Figs. 2 and 3, the balls 39 and 47 are provided with right angularly disposed slots 56 for receiving the inward projections 55 to thereby locate the insert on the ball surface and prevent it from rotating. Preferably a bonding material 57 is provided therebetween to securely bond the insert on the ball surface. A lubricant may be placed in the exterior slots 54 of the insert before pressure is provided between the socket 37 and the ball 39 sufficiently to deform the presettable material of the insert 45 to the exact shape of the mating surface of the socket and ball. Heat is then applied to the assembly when under pressure to finally cure the material of the insert to have it retain the exact shape of the spherical sections of the socket 57 in bearing relationship therewith. While it is a simple expedient in the art to accurately finish and polish a ball surface, it is difficult to maintain exact diameters so that a metal ball could accurately be machined to mate with a socket surface. By accurately molding the insert to the ball or socket bearing surface, accurate mating relationship occurs over the entire mating area without the ball and socket being of exact mating diameters.

The insert 35 is constructed in a similar manner, the interior of the insert being the bearing surface for the ball 24. A pair of the sector elements 35 is assembled on the ball, one from the top and the other from the bottom and pressure is provided by the plates 29 and 31 before and during the time heat is applied to set the resinous material which thereafter remains accurately

shaped to the ball. In the form herein illustrated, slots 54 are disposed in the inner face of the insert and the projections 55 are omitted, although these could be provided. A suitable bonding material 57 secures the inserts to the dish-shaped portions of the plates 29 and 31. The shaping of the inserts to the ball with pressure on the insert material when in presettable stage and the hardening of the inserts thereafter is illustrated, described and claimed in the copending application of Charles S. White, Serial No. 396,693, filed December 8, 1953, now Patent No. 2,835,521, for Ball Joint Bearing Structure.

The invention is not limited to inserts for ball and socket joints hereinabove described by way of example, but as shown in Figs. 4, 14 to 19 inclusive, the invention has many other applications. In Fig. 4, for example, a tapered spline shaft 61 is to be mated within the tapered splined aperture of a supporting element 62 without any play therein and with surface engagement throughout the entire mating area. In such an arrangement, a splined sleeve 63, made of a thermosetting resin in the presettable stage, is shaped to mate with the splines of the elements 61 and 62 and inserted therebetween. Upon the application of pressure longitudinally between the elements 61 and 62, the material of the splined sleeve 63 is formed to engage the entire mating surfaces between the spline projections and recesses and when heat is applied to the assembly the material of the sleeve is hardened and a substantially solid driving relationship results between the shaft 61 and the supporting element 62.

In Fig. 13 it will be noted that the resinous material 64 of the insert 51 is forced about the threads 65 and 66 of the Teflon cloth material which physically bonds the threads to the resin and provides a film of resin over the outer surface of the threads. This film of material is removed by the vapor blast process or other means as hereinabove referred to before the insert is finally shaped and hardened in the socket assembly.

In Figure 16 a further form of the invention is illustrated, that wherein particles 67 of brass, iron and the like are sintered together in a manner well-known in the art, but in the present instance is sintered in the presence of the Teflon, or like material 68 which fills the interstices between the particles 67. With this arrangement, the Teflon, or like material provides the low friction characteristics for the bearing surface, which thereby eliminates the use of a liquid lubricant commonly employed.

In Figs. 14 and 15, a further form of the invention is illustrated, that wherein a heavy journaled sleeve is disclosed similar to that employed on railway cars. The backing 69 of the bearing is constructed in a well known manner of resinous material of sufficient strength and durability to support a load and prevent the cold flow thereof. The surface of the material 71 is made from a sheet of Teflon, or like material, which is embedded therein in the manner hereinabove referred to, which provides the low friction characteristic to the engaging surface of the bearing, which thereby reduces the heavy break-away force which would otherwise be required.

In Figs. 17 and 18 a similar form of the invention is illustrated, that wherein a resinous backing material 72 is bonded to a metal sleeve 73 having a thread 74 on the outer surface. The inner bearing surface 75 has the Teflon, or like sheet as hereinabove described embedded therein. The two units are assembled together and threaded within a sleeve 76 which supports the bearing and prevents the endwise movement thereof.

It will thus be seen that the bearings hereinabove described are formed with a backing or body portion which resists deformation under load. The interstices of the bearing face are filled with Teflon, or like material which is physically anchored to the body material when the base material is [illegible] hardened. When the bearing is made of sinter particles, the Teflon, or like material, when heated, forms a jell which fills all of the interstices between the particles, to thereby provide the low friction characteristic to the resulting bearing element. When the body material is a resinous material, the Teflon, or like material is preferably in woven or sheet form, having interstices through which the resin may pass to physically anchor the material thereto. Such bearings are capable of withstanding load shocks while having a desired low friction characteristic without the presence of a lubricant. Recesses, however, may be provided in the bearing surface in which a lubricant may be retained to further reduce the friction engagement between the bearing surfaces.

What is claimed is:

1. The method of forming an insert for a ball and socket joint which includes the steps of: assembling an insert of postsettable resinous material having a layer of pervious resin material of low friction characteristics on the bearing face thereof, preforming the assembly to substantially the shape of the ball and socket of the joint, removing the excess resinous material from the face of material having the low friction characteristics, and assembling the inserts between the ball and socket under pressure while applying heat thereto to harden the postsettable resin when having the shape of the bearing surface.

2. The method of forming an insert for a ball and socket joint which includes the steps of: assembling an insert of postsettable resinous material having a layer of pervious resin material of low friction characteristics on the bearing face thereof, preforming the assembly to substantially the shape of the ball and socket of the joint, removing the excess resinous material from the face of material having the low friction characteristics, assembling the inserts between the ball and socket under pressure while applying heat thereto to harden the postsettable resin when having the shape of the bearing surface, and placing a lubricant in recesses in the bearing surface of the insert before the assembly of the insert with the ball and socket.

3. A bearing having a metal body with a face of hardenable material thereon, and Teflon threads woven into a cloth, the protruding portions of the rear face of the Teflon threads being embedded in the hardenable material which extends into the interstices between the weave of the threads to mechanically anchor the cloth to the body, substantially all of the front face of the threads being disposed above the hardenable material to provide the low friction surface for said bearing.

4. A bearing element having a face of hardenable material, and Teflon threads interrelated to form a cloth-like element, the protruding portions of the rear face of the Teflon threads being embedded in the hardenable material which extends into the interstices between the threads to mechanically anchor the cloth-like element to the hardenable material, substantially all of the front face of the threads and cloth-like element being disposed above the hardenable material to provide the low friction surface for said bearing element.

5. A composite bearing material of strip form having one surface formed of hardenable material and the other surface formed of low friction Teflon threads interrelated to form a cloth-like element, the protruding portions of the rear face of the Teflon threads being embedded in the hardenable material which extends into the interstices between the threads to mechanically anchor the cloth-like element to the hardenable material, substantially all of the front face of the threads being disposed above the hardenable material to provide the low friction surface for said composite bearing material.

6. The method of forming a bearing having a body with a face of hardenable material thereon which includes the steps of: embedding the rear face of a layer of Teflon [illegible] into said face to mechanically retain the cloth-like element against movement relative to the body, and thereafter removing

the exposed hardenable material from the front face of the cloth-like element so that substantially all of the front face disposed above the hardenable material provides the low friction surface for the bearing.

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May 5, 1959 C. S. WHITE 2,885,248

MOLDED BEARING HAVING LOW FRICTION MATING SURFACES

Filed June 16, 1955

2 Sheets-Sheet 1

FIG. 1.

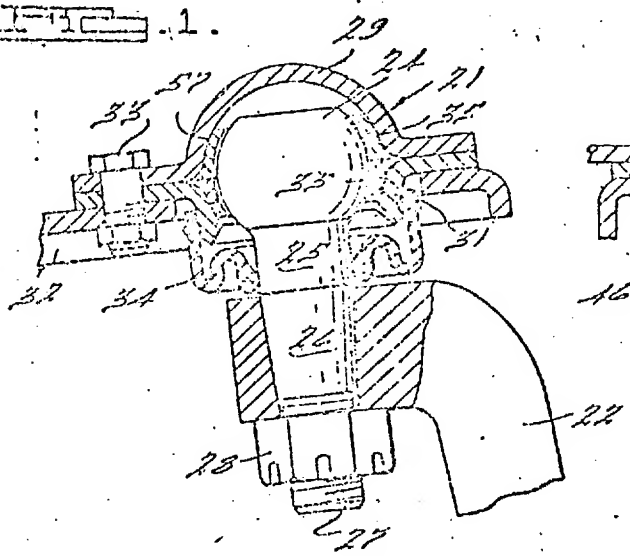


FIG. 3.

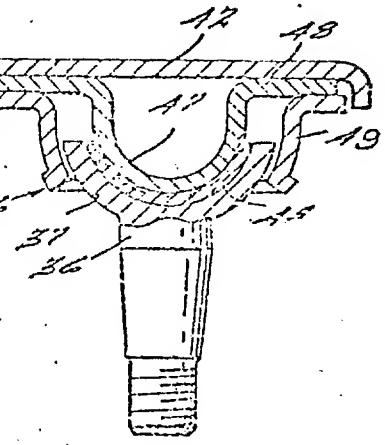
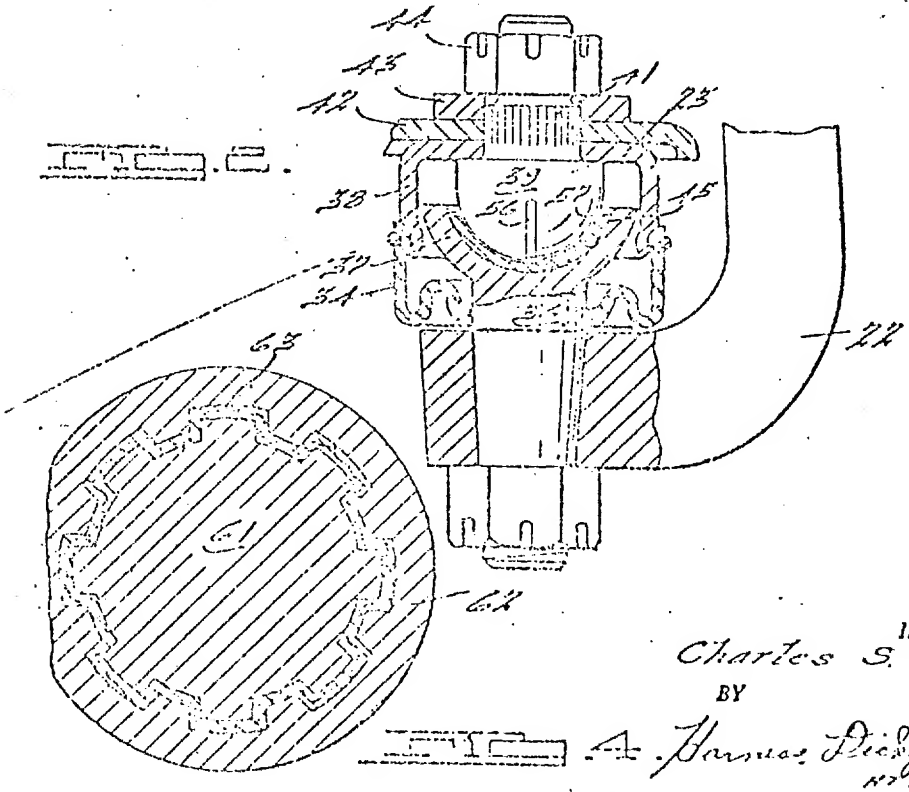


FIG. 2.



INVENTOR.
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BY
A. James Dickel & Price
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May 5, 1959 C. S. WHITE 2,885,248

MOLDED BEARING HAVING LOW FRICTION MATING SURFACES

Filed June 16, 1955 2 Sheets-Sheet 2

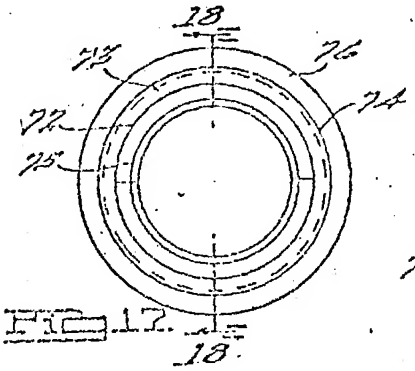


FIG. 17.

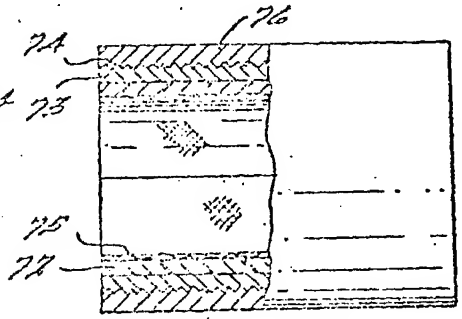


FIG. 18.

FIG. 14.

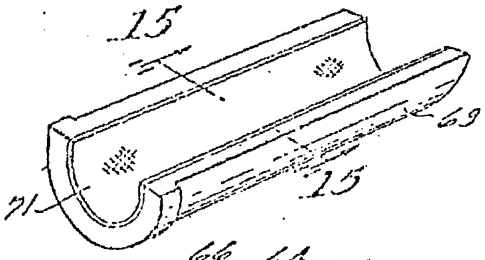


FIG. 19.

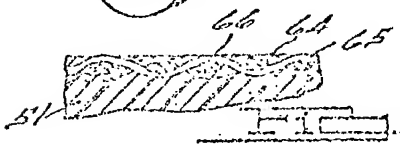


FIG. 13.

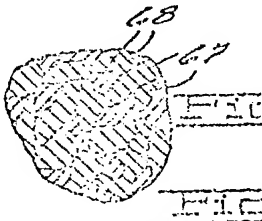


FIG. 16

FIG. 7.

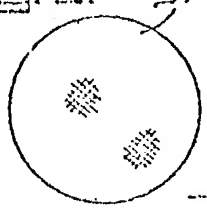


FIG. 8.

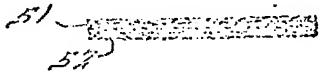
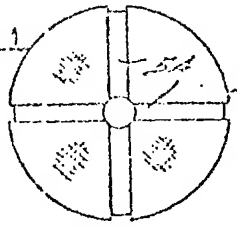
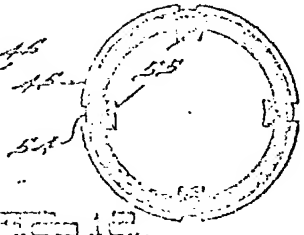


FIG. 9.

FIG. 11





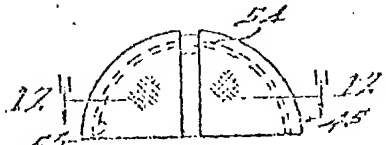


FIG. 10.

FIG. 12.

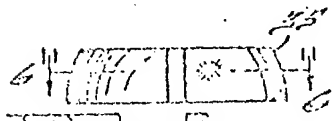


FIG. 5.

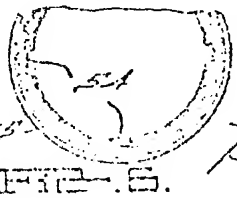


FIG. 6.

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United States Patent Office

Re. 24,765

Reissued Jan. 13, 1959

1

24,765

LOW FRICTION FABRIC MATERIAL

Charles S. White, Palmdale, Calif.

Original No. 2,791,536, dated May 7, 1957, Serial No. 544,943, November 4, 1955. Application for reissue January 19, 1955, Serial No. 737,767

7 Claims. (Cl. 139—420)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to low friction materials, and more particularly relates to a method for making and the fabrics which result from the use of such method and materials.

Low friction plastic materials have had very limited use as bearings, seals, pistons and the like, for different reasons, some of which are failures at low temperatures, cold flow, change in physical characteristics under heating and pressure, and lack of bonding characteristics.

The present invention primarily employs plastic materials which themselves have low friction characteristics, and is based on the discovery that unexpectedly useful low friction surfaces are produced if plastic materials having relatively low friction characteristics are employed in the form of fibers. A supporting surface is provided which retains the fibers in position to resist cold flow during the period of relative motion between the surface carrying the low friction material and the opposed surface when the surfaces are loaded. Various attempts have been made to support the low friction materials so as to resist cold flow during use and due to the simplicity of handling and ease in manufacturing, the present invention contemplates the employment of the fibers in a woven form. By this means the fibers are disposed and supported so as to be substantially uniformly distributed in or on a supporting surface woven into the fabric.

The compound fabric material having the low friction fibers is bonded to a body made from suitable materials to form bearings, seals, pistons and the like. The body material which supports the uniformly distributed fibers may vary substantially, that is to say, such material may be thermosetting and thermoplastic resins, such as phenol-aldehyde resins including particularly phenol formaldehyde resins, urea-formaldehyde resins, polyester resins, elastomeric materials including natural and synthetic rubbers and the urethanes. For application such as bearings or seals it will be apparent that the body material which is selected for any particular application must be one which has the ability to resist deformation and to retain its shape and properties under the temperature conditions resulting from use. It is therefore advisable to select a high temperature resistant material, preferably of the thermosetting type, such as phenol formaldehyde resins. It is to be understood that conventional fillers and tensile reinforcing fibers for such resinous materials may be incorporated if desired and are advisable where the resulting structure is to be subjected to relatively high unit pressures during use. For the worst conditions normally encountered in bearing and sealing applications, glass fiber filled resins are especially satisfactory.

Fibers having low friction characteristics which have been found to be satisfactory for the purposes of this invention include the polyamide resins marketed under the name of nylon, the polyester resins marketed under the

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name Dacron, polyethylene, the polymeric fluorocarbon resins including tetrafluoroethylene, marketed under the trade name Teflon, and the monochloro-trifluoroethylene resins marketed under the trade names of Kel-F and Fluorothene, available from M. W. Kellogg Co. and Union Carbide and Carbon Corp., respectively. For certain applications, vinyl chloride resin fibers, commercially available under the name Saran and marketed by Dow Chemical Company, are also useful. The tetrafluoroethylene resins are unusually superior to the other resin fibers for the purposes of this invention as they will withstand approximately 500° temperature, although it is to be understood that other fibers are satisfactory for lower temperature application and will even be preferred for certain applications because of lower cost and greater ease in manufacture, such as nylon and polyethylene fibers. The fibrous materials of this invention and the low friction surfaces prepared therefrom uniquely differ from solid bodies or sheets of the same material because in certain applications, where sheet materials have completely failed, fibers of that same material uniformly disposed and positively retained against flow on a similar surface have proved to be satisfactory. The low friction fiber material in most cases does not bond readily with other materials, and in order to assure a good bond, bondable fibers are woven on the reverse side of the woven low friction fibers so that on the working face of the resulting woven material a low friction surface will be provided and on the opposite face a bondable surface will be present. Thus assurance is had that the low friction fibers will be retained in position at all times since the bondable fibers are positively retained in position on the supporting material. For example, inherent resistance to bonding is possessed by the polymeric fluorocarbon resins and these fibers have been successfully woven on a conventional backing material such as cotton, rayon, nylon, wool, glass and the like, in such a manner that the working face carries uniformly distributed fluorocarbon resin fibers on its surface. In any arrangement fibers are employed on the working face having low friction characteristics, while dissimilar fibers or cords on the opposite face have bondable characteristics. This procedure facilitates the attachment of such fibers to the supporting body material directly by such fiber material or by the use of adhesion or bonding materials which will secure the cotton, rayon, wool, etc., thereto. Thus, the low friction face may be applied to a fabric having a bondable back face, to the face of a webbing material if body is desired back of the low friction face, or to the inner or outer sides of a fabric in sleeve form, with the opposite side having the bondable face.

In bearing and sealing applications, failure occurs when the low friction surface materials cold flow, spall or seize during use and although it has not been completely experimentally established, it is thought that the fibers are successful for the purpose of this invention relative to sheet materials because the fibers are much stronger in tensile strength than sheet material fabricated from exactly the same substance. For example, in the case of tetrafluoroethylene resins, the tensile strength is approximately twenty-five times greater than the tensile strength of the material in sheet form. The exceedingly high tensile strength of the tetrafluoroethylene resin in fiber or filament form provides substantial resistance against cold flow which occurs when the resin is in sheet or block form. Adding to this substantial resistance against cold flow by the fibers and the secure anchor provided by the bondable cords woven to one face of the fibers, assurance is had that a permanent low friction surface is provided [illegible]

The low friction materials of this invention have different characteristics [illegible]

defined as materials having a coefficient of [illegible] on against polished steel of [illegible] or less, [illegible] coefficients being obtained in the absence of conventional lubrications and in dry form. The polymeric fluorocarbon resins are stable and useful at temperatures through 500° F. and even as high as 600° in certain cases, and it can well be appreciated that such fibers backed with glass fibers will withstand high temperatures without deforming while retaining the low friction characteristics.

In the copending application of Charles S. White, Serial No. 396,893, filed September 8, 1953, *now Patent No. 2,835,521*, for Ball Joint Bearing Structures, a ball joint is illustrated having one element made from a plastic insert the shape of the ball which is set by the application of heat after the insert is shaped to the adjacent surface under pressure. When the compound fabric was secured to the insert with a surface of Teflon engaged with a mating polished surface, the joint was operated more than 600,000 times in the absence of a lubricant and under a load of 2200 pounds per square inch without any visible wear on the insert or surface. Under such a load the joint was expected to have a high breakaway characteristic, requiring a substantially greater force to initially move the joint than that required to move it thereafter. The breakaway load of the joint having the Teflon surface above described was surprisingly low, requiring no noticeable amount of applied force over that to move the joint after breakaway. For example, ball joints, such as those employed in an automobile having a load of 1200 pounds per square inch thereon have a static and dynamic force requirement to produce movement of 1½ ft. pounds in each instance. After 300,000 cycles of operation, the force requirement in both instances was 1 ft. pound and at 600,000 cycles the force requirement was 1⅜ ft. pounds in both instances. In this test, a small amount of grease was applied to the metal face of the socket at the time of assembly. No wear or damage to the surfaces was found when examining the joint parts after the 600,000 cycles of operation.

Accordingly, the main objects of the invention are: to provide a compound fabric having a low friction surface on one side and a bondable surface on the opposite side; to provide a strip of webbing with a face of low friction fibers which is woven directly thereto; to provide a sleeve of fabric material having on the inner or outer face a low friction fabric material and on the opposite face a bondable material; to provide a compound fabric with a face of low friction fiber woven together to form a compact continuous surface having on one side thereof exposed cords of bondable material; and, in general, to provide a fabric having a face of low friction characteristics which is simple in construction and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a plan view of a fabric of the low friction type having bondable cords secured to one face thereof;

Fig. 2 is an enlarged sectional view of the structure illustrated in *Fig. 1 and also the backing member to which it is secured;*

Fig. 3 is a sectional view of a ball forming a joint, with a woven low friction fabric face of a strip of webbing, embodying features of the invention;

Fig. 4 is a sectional view of a strip of webbing employed in the socket of Fig. 3 before pressure is applied thereto;

Fig. 5 is an enlarged plan view of the low friction webbing material illustrated in Fig. 4;

Fig. 6 is a sectional view of the woven webbing material illustrated in [illegible]

Fig. 7 is a perspective view of a sleeve woven to have

a low friction surface on the [illegible] made in accordance with the present invention;

Fig. 8 is an enlarged view of the weave employed to construct the sleeve, as viewed within the circle 8 of Fig. 7, and

Fig. 9 is a sectional view of the structure illustrated in Fig. 8, taken on the line 9—9 thereof.

It is to be understood that various types of weaves may be employed for forming the compound fabric having on one side thereof the low friction fibers and on the opposite side thereof the bondable fibers. For example, when the compound fabric is employed for faces of seals, the bodies of which have elastomeric properties, the compound sleeve must be able to expand and contract with the elastomeric material and should offer no resistance to the application of pressure by the material of the seal. The weaves herein illustrated therefore are merely shown by way of example and not by limitation, as it is to be understood that in different applications different types of weaves will be employed.

For a flat fabric, reference may be had to Figs. 1 and 2 wherein one method of weave is illustrated for producing the compound fabric having the substantially solid surface of the low friction fibers and the bondable backing layer, substantially all of which is made up of bondable fibers. The low friction fibers 10 form the warp of the fabric, while the fibers 11 form the filler thereof. The layer of bondable cords 12 is disposed parallel to the warp cords 10 and is retained by having each of the filler cords 11 pick up a bondable cord 12 at certain spaced points, herein illustrated as every fourth cord. The next adjacent filler cord 13 picks up the next adjacent bondable cord 14 and skips three of the adjacent bonding cords before picking up the next adjacent cord 14. The third filler cord 15 will pick up the next bonding cord 16 and will skip three bonding cords and pick up the next adjacent bonding cord 15. The fourth filler cord 17 will pick up the next adjacent bonding cord 18 and will skip three of the bonding cords until it picks up the next adjacent bonding cord 18. Thus, it will be seen that the greatest percentage of the bonding cord will be exposed for bonding purposes and will leave the opposite face of the fabric substantially solid with the warp cords 10 and the filler cords 11 of low friction material. A compound fabric is thus provided having low friction fibers on one face and bondable fibers or cords on the opposite face. *The layer of bondable fibers or cords 12 may be readily bonded to a backing member 19 by a layer of suitable bonding material 20. As stated previously the bonding material 20 can be any suitable material which will bond cotton, rayon or wool of the layer of bondable fibers 12 to the backing member 19, and the backing member can be made from any suitable material such as, for example, one of the thermosetting or thermoplastic resins mentioned previously, to form bearings and the like.*

In Figs. 3 to 6, a webbing 21 is illustrated having on the face 22 thereof the low friction fibers. The face of the webbing is woven somewhat as a sleeve about a plurality of lengths of cords 23 which fill the interior of the sleeve and provide body to the resulting web. The one face 22 has warp cords 24 and filler cords 25 of the low friction fibers woven together at the same time that warp cords 26 of cotton or other material are woven with filler fibers 27 of cotton or other material on the other face. The front and rear woven portions of the webbing are tied together by the cords 23 which securely retain the free lengths of cords 23 in position therebetween. The low friction webbing may be employed, as illustrated in Fig. 3, within a channel-shaped socket 28 which retains the webbing under pressure, with the low friction face encompassing the ball portion 31 of the resulting ball joint. In such an arrangement, it may be desired to have the [illegible] a wax, grease, [illegible] that has materials so that the cords will readily shift when the [illegible] of the socket 29 are forced

downwardly into parallel relation, as illustrated in the figure. This provides the desired clearance between the face of low friction material of the webbing and the ball which permits the initial movement of the ball without requiring a substantial breakaway force, permitting a uniform movement under a uniform pressure. It is to be understood that when depth is desired to the low friction face, the opposite face of the webbing being of cotton or like material, may be bonded to other body materials to which the low friction material will not bond.

In Figs. 7, 8 and 9, a further form of the invention is illustrated, that wherein a sleeve 33 is woven from low friction fibers and a cord of bondable material. In this arrangement, the cord of bondable material 34 skips four cords of the low friction material 25 as it is continuously wound into cylindrical form. The cord 34 engages an adjacent cord 35 each revolution while skipping the cord 35 prior engaged so that as the cord 34 is wound in cylindrical form at the end of five turns it will have engaged each of the five cords 35 of all of the groups of the low friction cords 35. It is contemplated that a sleeve of such material may be placed along the inner surface of bearing seals and the like, as illustrated in the copending application of Charles S. White, Serial No. 544,944, filed November 4, 1955, *now Patent No. 2,905,552*, for Sealing and Bearing Device Having Low Friction Sealing Faces. When the material of the seal has substantial movement, the sleeve of low friction material must contract or expand therewith, in which case the elastic hosiery weave known in the art is preferably employed in constructing the sleeve. The sleeve of the low friction material woven with the elastic hosiery weave will not restrict the expansion and contraction of the body material of the seal. It was pointed out above that the various weaves were herein illustrated by way of example and not to be considered limiting since other types of known weaves may better be employed for certain applications of the resulting fabric, webbing and sleeve materials. It is to be understood that the woven material of low friction fibers may be applied to strips of packing material to form a face thereon which, when compressed about a stem or rod within a packing gland, will have low friction engagement therewith. Such a packing material could be provided by the webbing 21 if all of the outer surface contained the low friction fibers. It is also to be understood that the low friction fibers could be retained upon a layer of material to which it is secured by bonding, weaving or the like to prevent the cold flow of the fibers when subjected to pressure. The specific examples recited herein are not to be considered limiting as the low friction fibers may be secured to a layer of material by other means not specifically recited, and the weave employed in producing the fabric may take any form known in the art to be suitable. Such other examples as illustrated in Figs. 3 to 9 inclusive form the subject matter of a divisional application pending in the United States Patent Office.

What is claimed is:

1. A compound woven fabric *antifriction bearing element* having threads of two different materials, the material of one thread having the properties of being bondable to a material *of a bearing member* for the purpose of retaining and positioning the other thread, the material of which *other thread is tetrafluoroethylene resin which* has low friction characteristics but which is not readily bondable to [other materials] *the material of the member*, the threads being so interwoven as to have those of [low friction characteristics] *tetrafluoroethylene resin* disposed substantially on one face of the fabric *to form the low friction bearing engaging surface for the member* and the threads having the bonding characteristics disposed on the opposite face thereof whereby the bonding threads may be secured in position in a manner which does not substantially [illegible] the *tetrafluoroethylene resin* [other] threads which are

securely anchored in place by [illegible] intertwining portions [illegible] are secured in position *to have the tetrafluoroethylene resin threads form the bearing surface.*

[2. A compound woven fabric for low friction surfaces and the like, threads of low friction resin material to which resins will not satisfactorily bond woven as a face material, and threads to which resins will bond woven into the threads of the face material on the opposite side from the usable face of said material so that when bonded the bonding of said second threads physically anchors said first threads at spaced points throughout the material.]

[3. A compound woven fabric for low friction surfaces and the like woven from threads of low friction resin material to which other resins will not bond, and threads woven on one side of said woven fabric to which resin material will bond in position to be secured together or to a member to have such secured threads securely anchor the woven fabric by means of the interwoven relation therewith.]

[4. In a compound woven fabric for a low friction surface and the like, threads of low friction material to which resins will not satisfactorily bond, and backing threads to which a resin will bond, said threads being woven into a cloth having sufficient threads of low friction material on one face to provide a surface of desired low friction properties with sufficient backing threads on the opposite face to provide a support for said low friction threads whereby said backing threads physically anchor said low friction threads at spaced points throughout the material against any substantial movement when said backing threads are secured against any substantial movement.]

5. A bearing comprising a backing member having a fabric material secured thereto to provide the working face thereof, said fabric material comprising a compound woven fabric having threads of two different materials, the material of one thread having the properties of being bondable to the backing member, the material of the other thread being a polymeric fluorocarbon resin, the threads being so interwoven as to have those of the polymeric fluorocarbon resin disposed substantially on one face of the fabric and the threads having the bondable characteristics disposed on the opposite face thereof, said bondable threads being bonded to the backing member to securely anchor the threads of the polymeric fluorocarbon resin in place as the low friction working face of the bearing.

6. A bearing comprising a backing member having a fabric material secured thereto to provide the working face thereof, said fabric material comprising a compound woven fabric having threads of two different materials, the material of one thread having the properties of being bondable to the backing member, the material of the other thread being a low friction material that will not readily bond to said bearing member, the threads being so interwoven as to have those of the low friction material disposed substantially on one face of the fabric and the threads having the bondable characteristics disposed on the opposite face thereof, said bondable threads being bonded to the backing member to securely anchor the threads of the low friction material in place as the low friction working face of the bearing.

7. A bearing comprising a backing member having a fabric material secured thereto to provide the working face thereof, said fabric material comprising a compound woven fabric having threads of two different materials, the material of one thread having the properties of being a low friction material having a coefficient of friction against polished steel in the absence of conventional lubricants of approximately 0.02 to 0.1, the material of the other thread being bondable to the backing member, the threads being [illegible] the low friction material disposed substantially on one face of the fabric and the threads having the bondable characte-

istics disposed on the opposite face thereof said bondable threads being bonded to the backing member to securely anchor the threads of the low friction material in place as the low friction working face of the bearing.

8. A bearing comprising a backing member having a fabric material secured thereto to provide the working face thereof, said fabric material comprising a compound fabric having fibers of two different materials, the material of one fiber having the properties of being bondable to the backing member, the material of the other fiber being a polymeric fluorocarbon resin, the fibers being so intermingled as to have those of the polymeric fluorocarbon resin disposed substantially on one face of the fabric and those having the bondable characteristics disposed on the opposite face thereof, said bondable fibers being bonded to the backing member to securely anchor the fibers of the polymeric fluorocarbon resin in place as the low friction working face of the bearing.

9. A compound woven fabric antifriction bearing element having threads of two different materials, the material of one thread having the properties of being bondable to a material of a bearing member for the purpose of retaining and positioning the other thread, the material of which other thread is a polymeric fluorocarbon resin which has low friction characteristics but which is not readily bondable to the material of the member, the threads being so interwoven as to have those of polymeric fluorocarbon disposed substantially on one face of the fabric to form the low friction bearing engaging surface for the member and the threads having the bonding characteristics disposed on the opposite face thereof whereby the bonding threads may be secured in position in a manner which does not substantially affect the low friction properties of the polymeric fluorocarbon resin threads which are securely anchored in place by the intertwining portions of the bondable threads after the latter are secured in position to have the polymeric fluorocarbon resin threads form the bearing surface.

10. A compound woven fabric antifriction bearing element having threads of two different materials, the material of one thread having the properties of being bondable to a material of a bearing member for the purpose of retaining and positioning the other thread, the material of which other thread is a low friction material not readily bondable to the material of the member and having a coefficient of friction against polished steel in the absence of conventional lubricants of approximately 0.02 to 0.15, the threads being so interwoven as to have those of low friction characteristics disposed substantially on one face of the fabric to form the low friction bearing engaging surface for the member and the threads having the bonding characteristics disposed on the opposite face thereof whereby the bonding threads may be secured in position in a manner which does not substantially affect the low friction properties of the other threads which are securely anchored in place by the intertwining portions of the bondable threads after the latter are secured in position to have the low friction threads form the bearing surface.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Reissue No. 24,765 January 12, 1960

Charles S. White

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 56, for "bearing", in italics, read --- backing --- in italics.

Signed and sealed this 16th day of August 1960.

(SEAL)

Attest:

KARL H. AXLINE ROBERT C. WATSON

Jan. 12, 1960 C. S. WHITE Re. 24,765

LOW FRICTION FABRIC MATERIAL

Original Filed Nov. 4, 1955 2 Sheets-Sheet 1

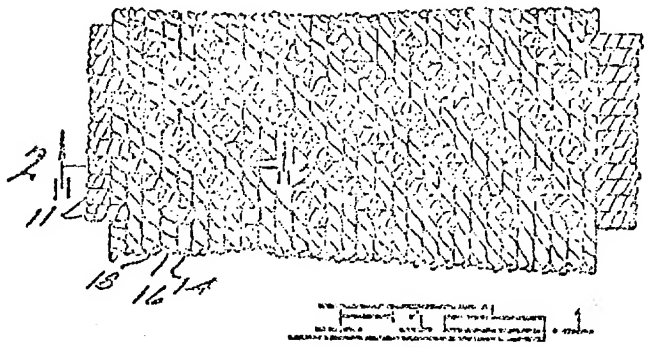


Fig. 1.

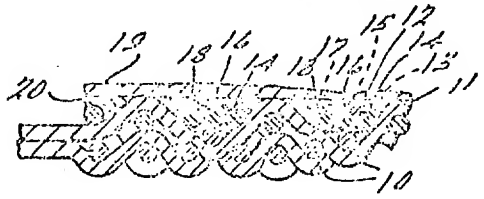
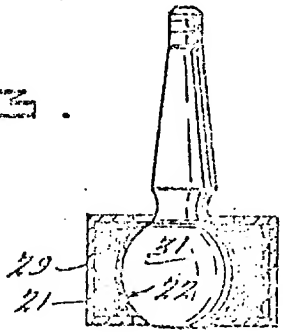


Fig. 2.

Fig. 3.



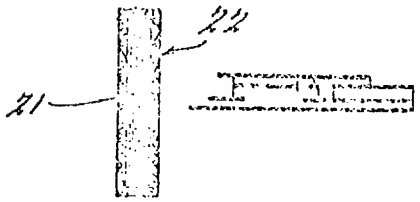


Fig. 4.

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Jan. 12, 1960 C. S. WHITE Re. 24,765

LOW FRICTION FABRIC MATERIAL

Original Filed Nov. 4, 1955

2 Sheets-Sheet 2

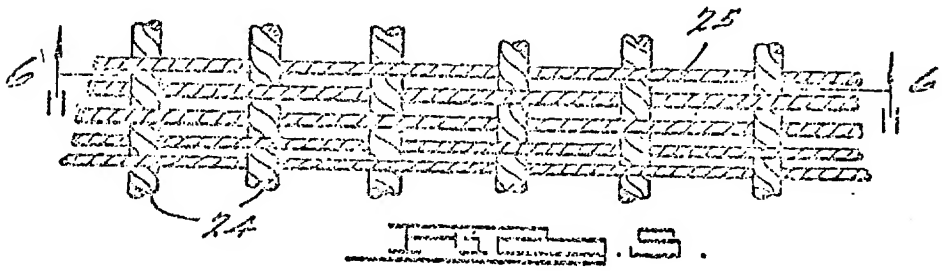

FIG. 5.

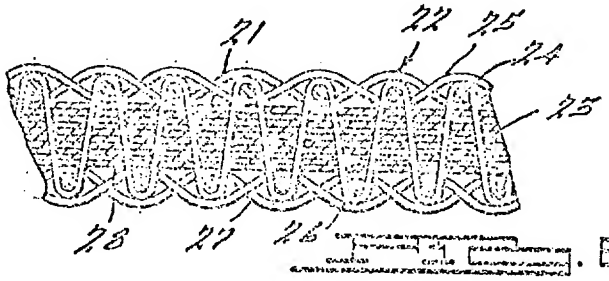

FIG. 6.

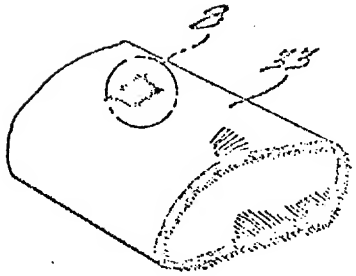

FIG. 7.

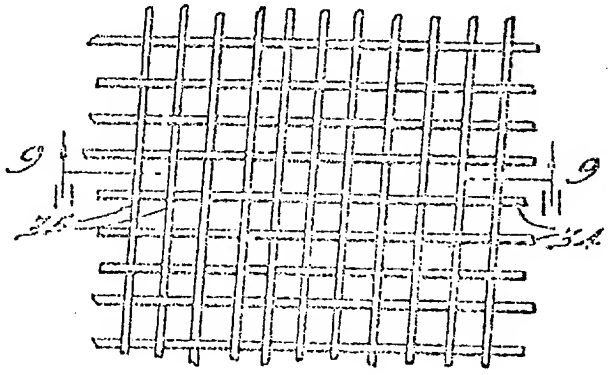

FIG. 8.

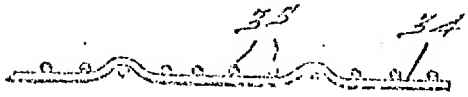

FIG. 9.

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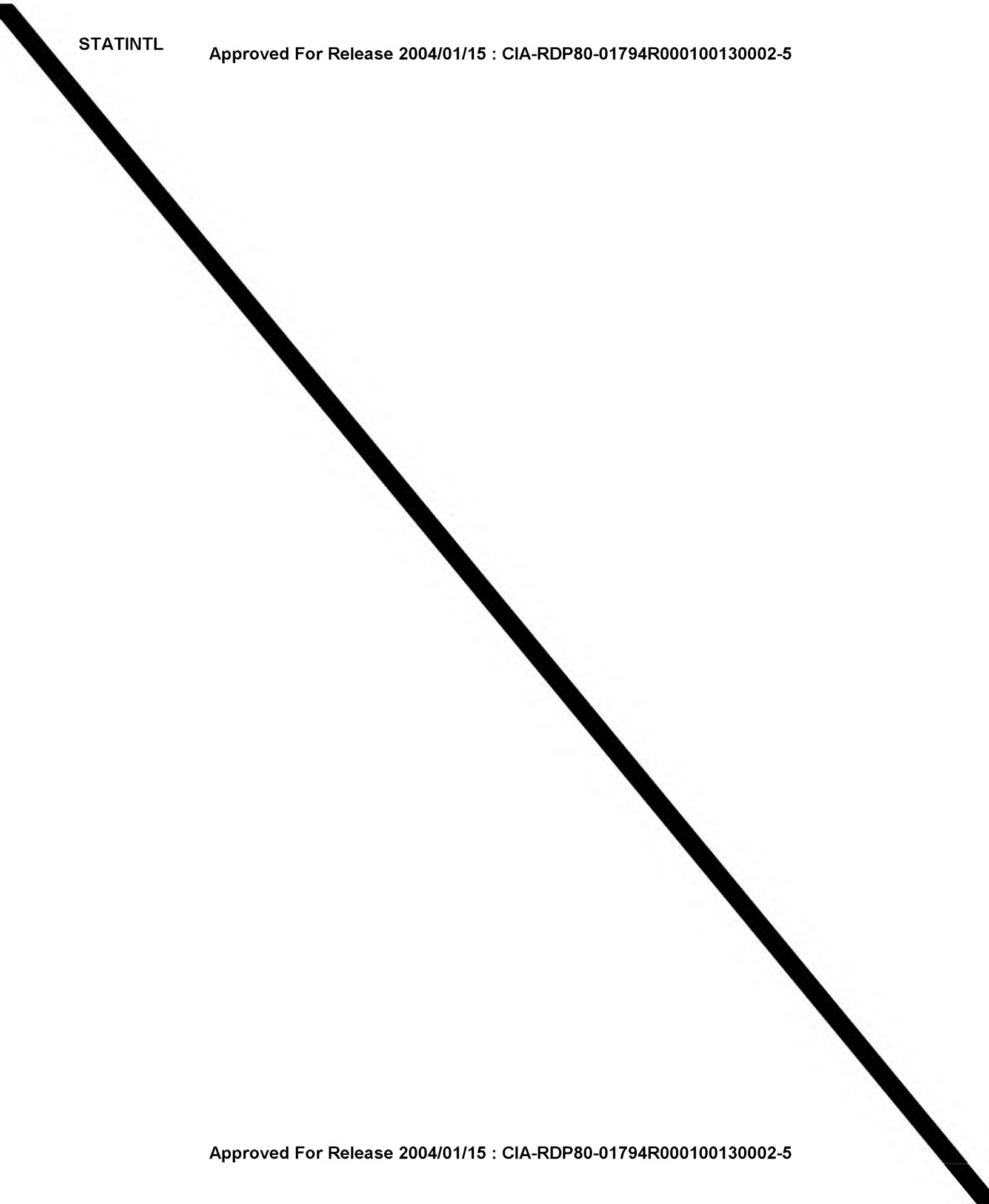

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